



Analysis of Water Quality Parameters and Heavy Metals Concentration from the Selected sites of Tamiraparani River, Tirunelveli District, Tamilnadu, India

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Abstract

In this present investigation deals with the physio-chemical and heavy metals analysis from the selected study areas of river Tamiraparani, Tirunelveli, Tamil Nadu, India. The water samples were collected from the Thalaianai and Cheranmadevi sites during the pre-monsoon, post-monsoon and summer. The parameters were performed with the standard methods of APHA, 2005. Water samples elements were determined by using Atomic Absorption Spectrophotometer (AAS). The parameters analyzed were Air temperature, Water temperature, pH, Electrical conductivity, Hardness, Alkalinity, Dissolved oxygen, Chemical oxygen demand and Biological oxygen demand. The heavy metals were found at Cheranmadevi site only but not in Thalaianai site. Most of the pollution accrued in the Cheranmadevi river due to modern wastage and anthropogenic impacts. Hence, these selected river sites polluting and aggregate outcomes are a danger to the whole environment.

Keywords: Physio-chemical parameters, Heavy metals, Tamiraparani river, Thalaianai, Cheranmadevi, Atomic Absorption Spectrophotometer.

Introduction

Annually, India acquires by a concerning amount of 1400-1800 mm rainfall. This acquired rainwater of about 96% is utilized for agriculture, 3% for domestic use and 1% for industrial activity. An investigation exposed about 70% of all the available water in our country is polluted due to the expulsion of domestic wastages, agricultural pesticides and industrial wastages drain to the river¹. On Earth, the freshwater riverine ecosystem is the most important factor to life for sustaining human populations. This fraction of freshwater ecosystem is an extraordinary in high level of biodiversity which is directly supported through the range that includes running waters in rivers, lakes and availability of seasonal wetlands². However, the riverine ecosystems face habitat loss, degradation and as a consequence of many fish species status has become threatened in many rivers from the intense of anthropogenic activities.

The main rootages are degradation of habitat structure and defragmentation of the riverine ecosystems³. Thus, the conditions of aquatic environment life are largely governed by physio-chemical characteristics which enabled biota to develop many adaptations that progress sustainable production⁴. In generally, fresh water is a finite resource, indispensable for agriculture, industry and even for human existence. However, the adequate quantity and quality of fresh water without any sustainable development will not be possible⁵. Soils receiving applications of organic manures, fungicides and pesticides have frequent increases high concentration of extractable heavy

metals and that thereby increase their concentration in runoff⁶, while falling as rain, small amounts of gases, ions, dust and particulate matter from the atmosphere integrated into the water⁵. Inorganic carcinogens include certain metals such as chromium, cadmium, lead and mercury and complex silicates⁷. Metals are present in very low concentrations in natural aquatic ecosystems⁸ an accelerated release of heavy metals into the freshwater river poses serious water pollution problems because of their toxicity⁹, persistent determination and bioaccumulation in food chains of the aquatic ecosystems¹⁰. The objectives of the study are: i. To assess the present water quality, through analysis of some selected water quality parameters like Air temperature, Water temperature, pH, Electrical conductivity, Hardness, Alkalinity, Dissolved oxygen, Chemical oxygen demand and Biological oxygen demand. ii. To detect the heavy metals present in the selected river sites. iii. To interpret the data by using Correlation variation of Bivariate analysis. In this present study, an attempt has been taken to study and simulate the environmental condition along the river and predict the pollution status of water from the selected two sites of the river Tamiraparani, Tamil Nadu, India.

Materials and Methods

Study area: The River Tamiraparani is one of the perennial rivers of Southern Western Ghats, Tirunelveli district, Tamil Nadu. The river is fed by its tributaries as well as by monsoons. There are various small tributaries interlinking the river. During this study, two sites were selected which was covered by

upstream and the other one is downstream of the river Tamiraparani. The study site localities lie between the upstream of Thalaianai (latitude range N 08°42'31.23"-E 77°22'05.81" (Altitude range 267m)) and Cheranmadevi (N 08°42'03.0"-E 77°34'02.1" (Altitude range 59m)).

Water sampling: The water samples were collected in 2L plastic containers and brought to the laboratory for further analysis. The physio-chemical parameter based on air and water temperatures were measured at sampling time by using the mercury-in-glass thermometer, pH was estimated by using the standardized pocket P^H meter and the conductivity was measured by using the conductivity meter, dissolved oxygen was estimated by Winkler's methods¹¹. The Total hardness, Alkalinity, Total dissolved solids, Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) were analyzed by APHA¹². The results of scrutiny were expressed as mg/L except temperature as °C and conductivity measured as µs/cm respectively.

Heavy metals analysis in water: The water samples of bottles were labeled and immediately a few drops of HNO₃ were added in order to prevent loss of metals. Each acid digested water sample of 100 cm³ was taken in the beaker and the beaker was kept in an oven at 70°C to reduce the volume of the water up to 50 cm³. The concentration of Cadmium (Cd), Hexavalent chromium (Cr VI), Mercury (Hg) and Lead (Pb) in each water sample were determined by using an Atomic Absorption Spectrometer (AAS: AAS: LABINDIA: AA- 7000) AAS required an acid digestion step prior to analysis by treating the samples with concentrated HNO₃. Digestion of samples is performed essentially as described in standard method in American Public Health Association¹².

Statistical Analysis: The variations in two different sites of each parameter were compared by using Correlation variation of Bivariate analysis (Pearson Correlation and Flag significant correlation were analyzed). A Correlation is significant at the 0.01 level and 0.05 level (2-tailed) were performed with IBM SPSS statistics ver. 20.

Results and Discussion

The physio-chemical water parameters were summarized in (Table-1 and Figure 1-9). Even though, the water quality parameters were analyzed in diverse monsoon variations from Pre-monsoon, Post-monsoon and summer in the selected study sites as represented in (Figure-1-9). In the case of pH, values decreasing in the summer at Cheranmadevi site (Figure-3). The basic unit of measurement for conductivity is micromhos per centimeter (µS/cm) which was high at pre-monsoon period conductivity increasing at Cheranmadevi site; incase of conductivity was similarly increasing in the post monsoon period as shown in (Figure-4). Also the Hardness was high in the post monsoon and summer at Cheranmadevi (Figure-5). However, significant increases in conductivity may be an

indicator that polluting discharges have entered the water. Figure-7. implies the graphical representation showing the dissolved oxygen data often in the sampling point was high at Thalaianai site to all the season and low in Cheranmadevi site. Among them, the human factors that affect the dissolved oxygen in rivers includes addition of oxygen consuming organic wastes such as sewage, addition of nutrients, changing in the flow of water, raising the water temperature and addition of chemicals. The dissolved oxygen increasing levels at the river sites indicates the good aeration for sustaining the aquatic life. While in the case of biochemical oxygen demand its often increasing at Cheranmadevi during the post monsoon and summer as graphically shown in (Figure-9). Chemical oxygen demand (COD) is the other important parameter for water quality assessment. During the summer, its high at Cheranmadevi site as graphically shown in (Figure-8). The COD levels were very high, indicating that the decomposition of matter in the riverine ecosystem is consuming a high level of oxygen. This means that there would be oxygen left to support the other aquatic animals.

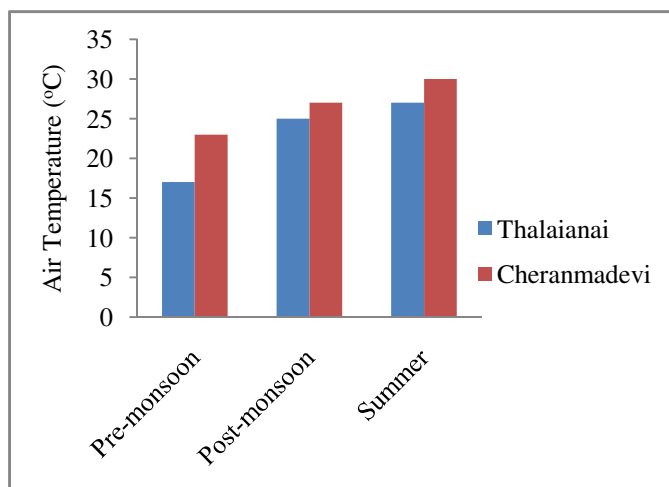


Figure-1
Three season period of Air Temp. in sampling sites

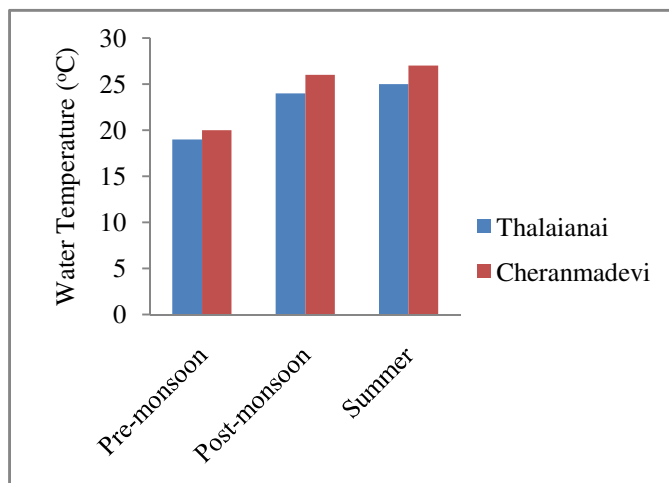


Figure-2
Three season period of Water Temp. in sampling sites

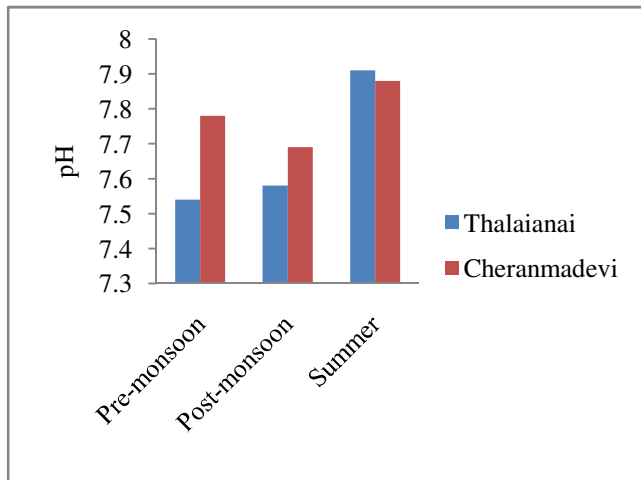


Figure-3
 Three season period of pH in sampling sites

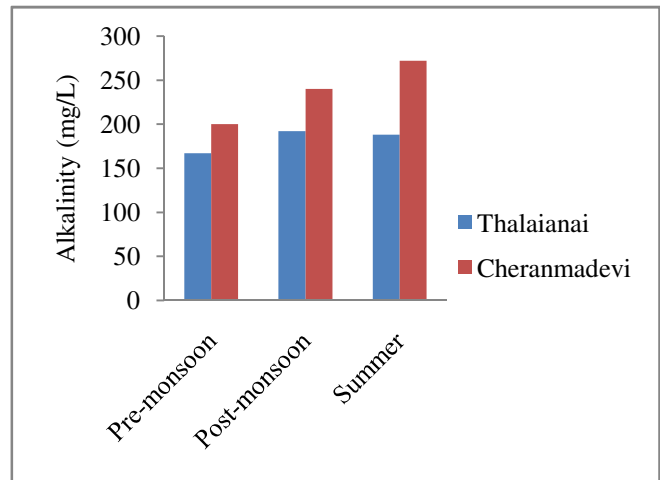


Figure-6
 Three season period of Alkalinity in sampling sites

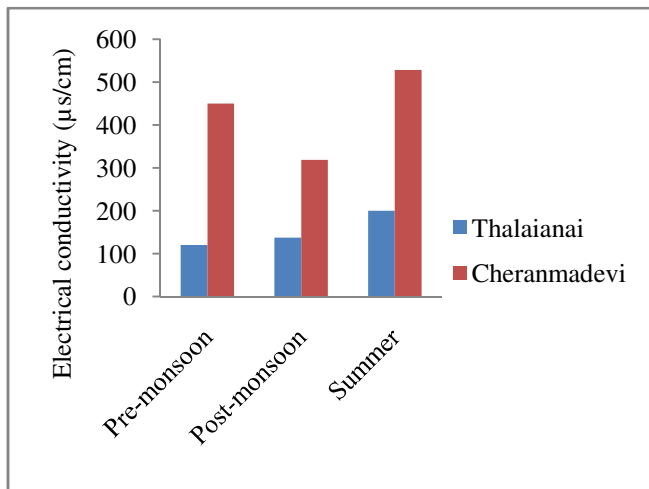


Figure-4
 Three season period of EC in sampling sites

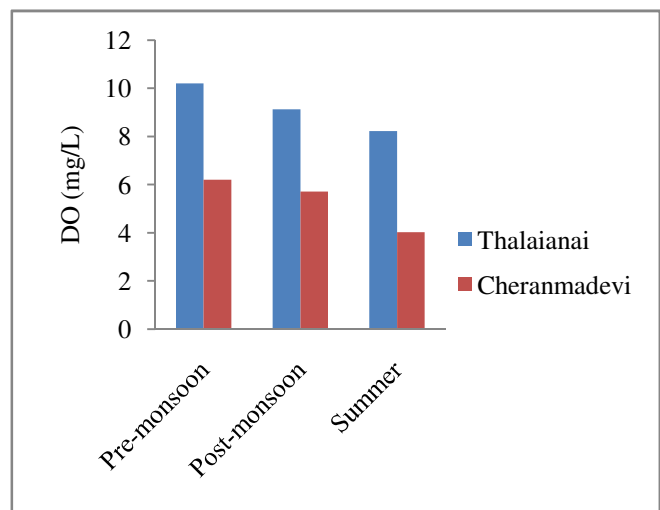


Figure-7
 Three season period of DO in sampling sites

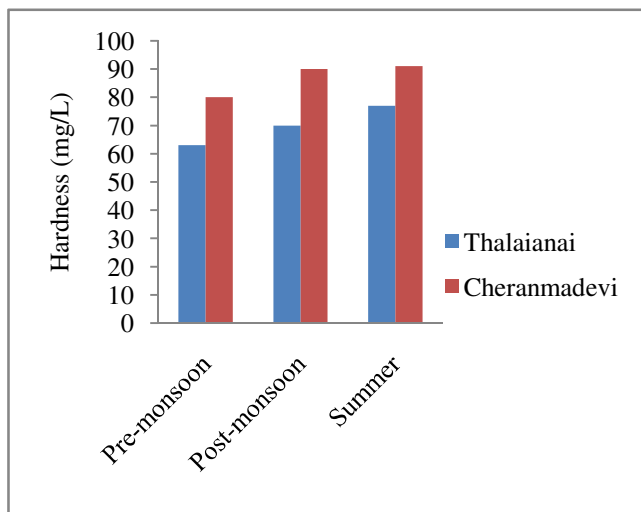


Figure-5
 Three season period of Hardness in sampling sites

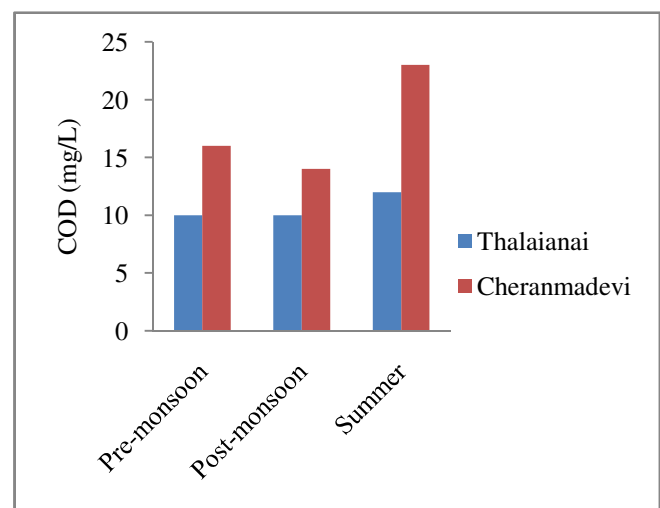


Figure-8
 Three season period of COD in sampling sites

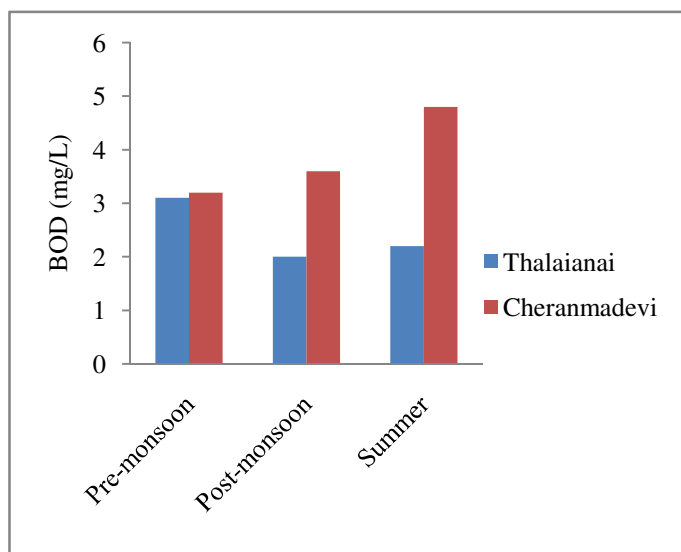


Figure-9
Three season period of COD in sampling sites

Dissolved oxygen was high at all sites except in Thalalaianai site as $(9.19 \pm 0.99 \text{ mg/l})$, the higher values of dissolved oxygen level shows a good aeration of the river. As it is supported by the fact that the lowest DO level at Cheranamadevi site as (5.32 mg/l) was recorded at this reputed site. The pH of the sampling stations ranged between 7.38 mg l^{-1} to 7.78 mg l^{-1} in the entire selected study sites. However, the electrical conductivity was high at Cheranamadevi site as (432.3 ± 105.6) . Total hardness, conductivity and alkalinity values were under permissible limits ranging from $(12-82 \text{ mg l}^{-1})$, respectively. But in the selected site of Cheranamadevi site showed that the total hardness was more by screening the values as (87 mg/l) which was exemplified slightly as hard water. Also, the COD level at Cheranamadevi site was recorded; it might be a threat to the aquatic system in the river. Increasing trend of BOD and decreasing trend of DO is at Cheranamadevi site clearly indicates the increasing load of pollution.

High alkalinity (237.3 mg/l) at Cheranamadevi, subsequently also have high conductivity at Cheranamadevi site as $(432.3 \text{ } \mu\text{s/cm})$ site was probably increased because of the addition of domestic waste and industrial drainage from the nearby cities. Therefore, high values of BOD, COD, total hardness, alkalinity and conductivity and low values of pH and DO at Cheranamadevi site have an adverse effect on the abundance of aquatic organisms.

Correlation analysis of Physio-chemical parameters: Interrelationship studies between the different sites variables are very helpful tool in promoting research and opening the new fields of knowledge. The study of correlation reduces the range of uncertainty associated with decision making. The correlation coefficient analysis of various sites of the selected sites (Bivariate Pearson correlation and 2-tailed flag significant at the 0.01 and 0.05 levels were analyzed) was done by using SPSS

statistical tools and the data were depicted in (Table-3 and 4). In the site of Thalalaianai, the water having the high positively correlated value of the significant at 0.05 levels (0.999) was found between the water temperature and air temperature. Subsequently, the Dissolved Oxygen and Total hardness, BOD and alkalinity was significantly at the negative correlation as $(-0.999 \text{ and } -1.000)$ respectively as (Table 3). However in Cheranamadevi site, the high positively correlated values was significant at the 0.05 level (0.999) were found between the total hardness and water temperature and also (1.000) found between the alkalinity and air temperature as given in (Table-4). From that, the negative correlation was depicted between BOD and DO (-1.000) .

Analysis of Heavy metals in water: The mean and range of Lead (Pb), Cadmium (Cd), Hexavalent Chromium (Cr VI) and Mercury (Hg) in water samples from selected sites of river Tamiraparani were shown in Table 2. The metals were found to be in the order of $\text{Pb} > \text{Cr} > \text{Cd} > \text{Hg}$ in River Tamiraparani. Hg have the below detection limit in the water samples at Thalalaianai.

The mean concentration of Pb in water samples from selected sites of River Tamiraparani were high at (0.23 mg/L) . However, the Cr concentration were (1.70 mg/L) , Hg concentration were (0.10 mg/L) , Cd concentration were (1.00 mg/L) respectively (Table-2). In case of the Thalalaianai site, the water was not detectable other than the three metals which show health of the river.

Table-1
Physio-chemical parameters analysis from selected two locations of the Tamiraparani river

Physio-chemical parameters	Sampling Sites	
	Thalalaianai	Cheranamadevi
	Mean±SD*	Mean±SD*
Air Temp.	23±5.29	26.67±3.51
Water Temp.	22.67±3.21	24.3±3.79
pH	7.68±0.20	7.78±0.95
EC	152.3±42.15	432.3±105.6
Total Hardness	70±7.00	87±6.08
Alkalinity	182.3±13.43	237.3±36.07
DO	9.19±0.99	5.32±1.14
COD	10.67±1.15	17.67±4.73
BOD	2.43±0.59	3.87±0.83

Table-2
Heavy metals concentration from different locations of Tamiraparani river

Element	Thalaianai	Cheranmadevi
Lead	Below<0.05	0.23
Chromium	ND	1.70
Mercury	ND	0.10
Cadmium	ND	1.00

Table-3
Correlation between Physiochemical parameters on the Thalaianai site of Tamiraparani river (Pearson Correlation and Flag significant correlation were analyzed).

Physio-chemical Parameters	Air Temp	Water Temp	pH	EC	Total Hardness	Alkalinity	DO	COD	BOD
Air Temp	1	.999*	.726	.794	.945	.943	-.960	.655	-.935
Water Temp	.999*	1	.702	.773	.933	.954	-.950	.629	-.947
pH	.726	.702	1	.995	.911	.455	-.889	.995	-4.36
EC	.794	.773	.995	1	.949	.546	-.932	.979	-.527
Total Hardness	.945	.933	.911	.949	1	.782	-.999*	.866	-.768
Alkalinity	.943	.954	.455	.546	.782	1	-.812	.365	-1.000*
DO	-.960	-.950	-.889	-.932	-.999*	-.812	1	-.840	.799
COD	.655	.629	.995	.979	.866	.365	-.840	1	-.345
BOD	-.935	-.947	-.436	-.527	-.768	-1.000*	.799	-.345	1

Table-4
Correlation between Physiochemical parameters on the Cheranmadevi site of Tamiraparani river (Pearson Correlation and Flag significant correlation were analyzed)

Physio-chemical parameters	Air Temp	Water Temp	pH	EC	Total Hardness	Alkalinity	DO	COD	BOD
Air Temp	1	.953	.454	.292	.936	1.000*	-.923	.683	.735
Water Temp	.953	1	.162	-.013	.999*	.947	-.763	.429	.782
pH	.454	.162	1	.985	.112	.471	-.761	.961	.741
EC	.292	-.013	.985	1	-.063	.309	-.636	.898	.613
Total Hardness	.936	.999*	.112	-.063	1	.930	-.730	.383	.750
Alkalinity	1.000*	.947	.471	.309	.930	1	-.930	.696	.941
DO	-.923	-.763	-.761	-.636	-.730	-.930	1	-.911	-1.000*
COD	.683	.429	.961	.898	.383	.696	-.911	1	.898
BOD	.935	.782	.741	.613	.750	.941	-1.000*	.898	1

Discussion: In freshwater ecosystems, the physio-chemical characteristics of water have an imperative role in supporting fish diversity to the river. It has been noted that the other dynamic features of the river ecosystem including physical, chemical and biological characteristics some alterations in fish community, may affect directly or indirectly. The fish fauna has been gravely affected by the habitat loss and degradation of environmental conditions. In changing circumstances, the conservation of fish diversity presumes the top most precedence of gradual habitat degradation. According to Basavaraja, the water quality parameters by seasonal variation were analyzed such as water temperature, pH, Electrical conductivity, DO, BOD, Total hardness has been recorded and also it has been checked for the status of freshwater fish diversity and its abundance¹³. Hence, these studies indicated that the dissolved oxygen was decreased and also the biological oxygen demand was in high level at Cheranmadevi site. So, the features accountable for fish retardation other than the physical stability like dynamiting, pollution threats, etc. However, the quality of water assessment in the river was coming under the category of slight pollution and moderate pollution was analyzed¹⁴.

Moreover, the physiochemical parameters were also very essential for the freshwater river, because of the life cycle of fishes and other aquatic organisms¹⁵. Also, the water quality analysis is essential for the aquatic organisms for sustainable life and also the pollution load by the microbial contamination in water was detected¹⁶. Furthermore, the municipal solid waste discharging the polluted ground water and changes the quality of water¹⁷. In case of that, the essentials to the aerobic metabolism of all aquatic organisms were the supplying parameter of dissolved oxygen to the river systems¹⁸. Our studies exemplified that the low Dissolved oxygen level was found at Cheranmadevi site due to the domestic waste and industrial drainage from the nearby urbanized areas. However, the discharge was with high levels of biological oxygen demand that can cause freshwater problems such as severe dissolved oxygen depletion and the fishes were killed in receiving water bodies¹⁹. In this current investigation, its ranges varied from 5.32 to 9.19mg/l. According to Praveen Tamot, reported that the DO values were in between 6.0 to 9.2mg/l in the Halali Reservoir which denoted the higher values of dissolved oxygen were evidenced during the raining season due to churning of water by heavy wind action and the amalgamation of monsoon rains²⁰⁻²². An indicator of water quality was the dissolved oxygen has been attributed a vast significance in particularly the magnitude of eutrophication. In water, dissolved oxygen concentration depends mainly upon the temperature, dissolved salts, velocity of wind, pollution load, photosynthetic activity, and respiration rate^{23,24}. The integration along with the history of the biological oxygen demand test into many major water quality models guaranteed that it will be continue to evaluate for decades in the future. Therefore, it probably diminished the aquatic ecosystems, their habitat alteration and has an effect on the survival of aquatic organisms.

The presence of Calcium and Magnesium salts largely combined with bicarbonates and carbonates (temporary hardness) with sulphates, chlorides and other anions of minerals (permanent hardness) which mainly governed the hardness of water by the above perceived contents. In the present study, its range varied from 70 to 88.6 mg/l. On the origin of hardness values, water of Halali Reservoir can be considered under moderately hard category²⁵. Although, the Alkalinity of any water was primarily due to carbonate, bicarbonate and hydroxide, it has been an index of nutrient status in a water body. For primary productivity, the accessibility of carbon dioxide was related to alkalinity. According to Moyle, the water bodies that have a total alkalinity of above 50 mg/l can be considered as productive²⁶. In our study sites, exhibited quantities of higher alkalinity were found in Cheranmadevi (237.3 mg/L. These can generate a high content of dissolved solids elevates the density of water, reduced oxygen and water utility for drinking, irrigational and industrial wastes to influence the osmoregulation of fresh water organisms. Among that, the factor of dissolved oxygen in water is of grand importance to all the aquatic animals' sustainable life and is considered to be a solitary role which has to be a great extent can revealed the nature of whole aquatic system signified in the production to sustain aquatic life. This parameter can be exploited as an index for net production and also an obligatory one for the decomposition and decaying of organic matter²⁷. However, the heavy metals pollution of rivers and lakes is a matter of great concern in any ecosystem in wetlands and water masses due to human toxicity and bioaccumulative effect. The Tamiraparani river is of great interest due to its economic and domestic implication in Tirunelveli region generally pointed to lower concentration from earlier report²⁸.

Pathetically, the heavy metals have been principally enter into the human body through drinking water and food which are known to have solemn health implications²⁹. Major foundations of these heavy metals in freshwater include atmospheric deposition, contamination of water in the natural geologic deposits and habitat alterations was due to the manufacturing process related to grimy substances and metals, discharges of municipal waste and domestic wastes³⁰. However, the mining and residential areas were polluting the ground water quality by the heavy metals concentration³¹. Naturally, the tissue degradations like various organic and inorganic water pollutants, metal ions are toxic, dangerous and harmful. The relative constant toxic heavy metals are also bioaccumulative over and above it is carcinogenic too. Therefore, it necessitates close monitoring of the river water and its aquatic organisms³². The concentration of trace metals in Gadilam river loading pollution due to the modern wastage and additional anthropogenic impacts to the riverine environment³³. The heavy metals of lead, hexavalent chromium and cadmium as poisoning are quite well known³⁴. In the present study, we found that the heavy metals like Lead, Hexavalent chromium, Cadmium ions in the Cheranmadevi river site which may have some quite carcinogenic effects due to presence of some suspected ions

when comparable to the Thalaianai site, where no such heavy metal ions were detectable.

Conclusion

From this above, the study indicates the water quality and heavy metals analysis of the Thalaianai and Cheranmadevi river of Tamiraparani. It terminates that the Thalaianai site shows the good and healthiness of the river environment. However, in the Cheranmadevi site shows moderately polluted due to some anthropogenic activities, agricultural pesticides, domestic wastes and industrial waste mixing in to the river. It should be quite concerned before the natives of enclosed adjoin may comes under the congestion of any fatal effects. Not only for the sake of adjoins but also for the conservation of aquatic ecosystems.

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